Single Image Super-resolution from Transformed Self-Exemplars

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Abstract Self-similarity based super-resolution (SR) algorithms are able to produce visually pleasing results without extensive training on external databases. Such algorithms exploit the statistical prior that patches in a natural image tend to recur within and across scales of the same image. However, the internal dictionary obtained from the given image may not always be sufficiently expressive to cover the textural appearance variations in the scene. In this paper, we extend self-similarity based SR to overcome this drawback. We expand the internal patch search space by allowing geometric variations. We do so by explicitly localizing planes in the scene and using the detected perspective geometry to guide the patch search process. We also incorporate additional affine transformations to accommodate local shape variations. We propose a compositional model to simultaneously handle both types of transformations. We extensively evaluate the performance in both urban and natural scenes. Even without using any external training databases, we achieve significantly superior results on urban scenes, while maintaining comparable performance on natural scenes as other state-of-the-art SR algorithms.

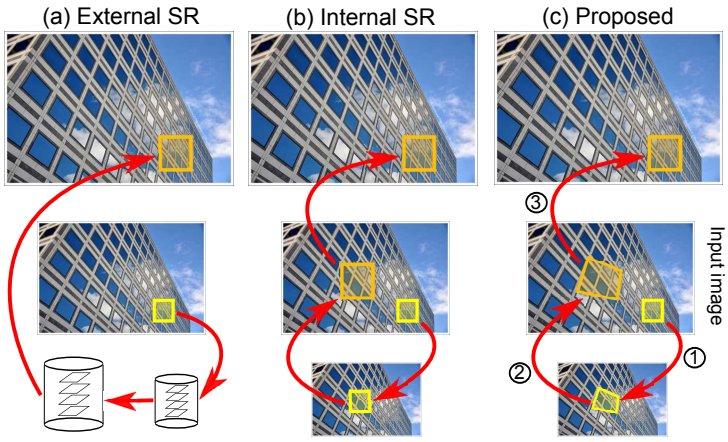

Figure 1: Comparison with external dictionary and internal dictionary (self-similarity) approaches. Middle row: Given LR image I. Our method allows for geometrically transforming the target patch from the input image, while searching for its nearest neighbor in the downsampled image. The HR version of the best match found is then pasted on to the HR image. This is repeated for all patches in the input image I.

Our Contributions

1. Our method effectively increases the size of the limited internal dictionary by allowing geometric transformation of patches. We achieve state-of-the-art results without using any external training images.

2. We propose a decomposition of the geometric patch transformation model into (i) perspective distortion for handling structured scenes and (ii) additional affine transformation for modeling local shape deformation.

3. We use and make available a new dataset of urban images containing structured scenes as a benchmark for SR evaluation.

Results Dataset, results, and source code are available on our project website https://sites.google.com/site/jbhuang0604/publications/struct_sr

This is an extended abstract. The full paper is available at the Computer Vision Foundation webpage.

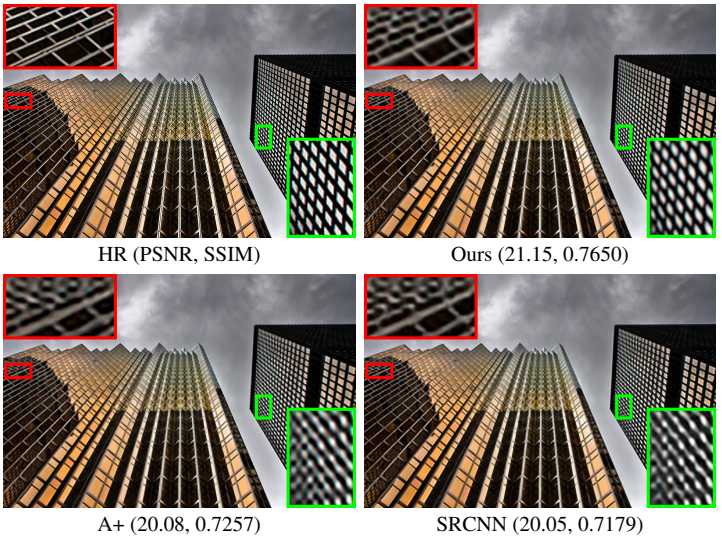

Figure 2: Visual comparison for 4x SR. Our algorithm is able to super-resolve images containing multiple planar structures.

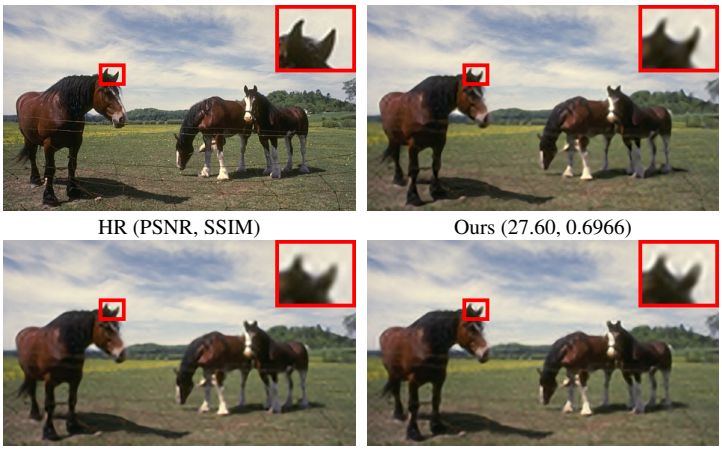

Figure 3: Visual comparison for 3x SR. Our result produces sharper edges than other methods. Shapes of fine structures (such as the horse's ears) are reproduced more faithfully in our result.

Figure 4: Visual comparison for 8x SR.